ON THE

ANTISEPTIC TREATMENT OF WOUNDS,

AND ITS RESULTS.

BY

ROBERT F. WEIR, M.D.,

SURGEON TO THE NEW YORK AND ROOSEVELT HOSPITALS.

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ON THE ANTISEPTIC TREATMENT OF WOUNDS, AND ITS RESULTS.[1]

It is only lately that, in America, attention has been given practically to the teachings of Lister in respect to the treatment of wounds. In fact, aside from an article by Schuppert in the *New Orleans Medical and Surgical Journal*, little or nothing has appeared in our medical journals relative to the results of the so-called antiseptic method. Within the past year, however, a change has occurred, due probably both to the interest excited by the personal expositions of Lister at our late Medical Congress at Philadelphia, and also to the satisfactory results that have ensued from this treatment in the practice of many German surgeons with large hospital experience. The reason why American surgeons—who justly have the reputation of being eager to seize upon any improvement in their art—have been tardy in testing the success of this mode of treatment, may, perhaps, be stated as follows: 1. That the treatment, as enunciated by Mr. Lister, has been repeatedly changed in its details; 2. That it was too complicated, and demanded the supervision of the surgeon himself, or, in a hospital, of a carefully-trained staff of assistants; 3. That many who had tried it had been unsuccessful in the cases where the essay had been made. But the most weighty objection which was asserted or entertained, was the positiveness of the enunciation of the germ-theory in explanation of the process of decomposition in the secretions of a wound. Only the latter reason requires any attention at present, and,

[1] Read before the New York County Medical Society at the meeting held November 26, 1877.

as a clearer conception of the intent of the many *minutiæ* of the dressing may come from a synopsis of this theory, it will be succinctly given, notwithstanding the purpose of this evening's paper is to present the subject as far as possible from a clinical point of view.

It is, in a few words, this: 1. That in the dust of the atmosphere, and in matter with which it is in contact, there are the germs of minute organisms, which under favorable circumstances induce putrefaction in fluids and solids capable of that change, in the same manner as the yeast-plant occasions the alcoholic fermentation in a saccharine solution; 2. That putrefaction is not occasioned by the chemical action of oxygen or other gas, but by the fermentative agency of these organisms; 3. That the vitality or potency of the germs can be destroyed by heat or by various chemical substances, which are called, in surgery, "antiseptics."[1] The very definition of the "antiseptic system," as given in the words of Lister himself, is "the dealing with surgical cases in such a way as to prevent the introduction of putrefactive influences into wounds."[2] Nothing need here be added to these statements, in their verification or otherwise (though analogy and accumulating facts seem to lend support to them), except that from the standpoint adopted two important statements ought to be referred to. I mean those of Thompson,[3] Weitzelbaum,[4] and others, that they had found living bacteria in the carbolic solutions as used by Lister, and of Linhart,[5] Fischer,[6] Ranke,[7] Schüller,[8] and Volkmann,[9] who, in several hundred observations, have found bacteria in the discharges of wounds that had been most carefully and satisfactorily treated by the antiseptic method. It was noticed, however, that the presence or absence of these bacteria (and such were only con-

[1] T. Smith, *Lancet*, March 25, 1876.

[2] "Transactions of the International Medical Congress," Philadelphia, 1876.

[3] *Medical Times and Gazette*, November 6, 1875.

[4] *Wiener Med. Presse*, 1876, Nos. 10 and 11.

[5] Schmidt's "Jahrbücher," vol. 174, 4.

[6] *Deut. Zeitschr. f. Chirur.*, vol. vi., p. 319.

[7] Idem, vol. vi., p. 63. [8] Idem, vol. vii., 1876, pp. 5, 6.

[9] Schmidt's "Jahrbücher," vol. 174, 2, 1877.

sidered as present, when chain-bacteria were found) did not influence the progress of the wounds; and Fischer gives the opinion, in which many of his countrymen join, that the object of the dressing is not so much to keep the germs away as to keep the secretions in such a condition as to be as unfavorable as possible to the development of bacteria, and thus prevent decomposition taking place.

It is only justice to append the remarks of Mr. Lister at the Congress in respect to these observations, or rather, correctly speaking, of Ranke's. They are, textually: "The statement that cell forms have been found beneath antiseptic dressings must be received with caution. I have," continues he, "recently met a gentleman who was with Ranke in Halle when he found, as he supposed, these organisms beneath antiseptic coverings; and when the gentleman pointed out to me the bacteria which he called putrefactive, I at once recognized them as of the non-putrefactive variety, and the gentleman was forced to admit that they differed from those found in decomposing masses." [1]

Passing from these facts (?) of the laboratory, let us consider those to be used and acquired at the bedside. In practicing this method, in order to form a proper judgment of its merits, it is essential that Mr. Lister's plan should be thoroughly known, and be carried out even to its minutest particular. The chorus on this point is unanimous among surgeons who have successfully used it. Hagedorn, of Magdeburg, says that in every failure the surgeon himself is to blame, and not the method; and Lindpaintner,[2] representing the experience of Munich with nearly a thousand cases treated antiseptically, states that it must be considered a precept that the minutest directions must be followed, and that he who does not get the result (desired) must certainly have made some mistake. This opinion is reiterated by all who have achieved success by the method, and the number of such is already large and increasing.[3] A second condition, which really

[1] "Transactions of the International Congress," 1875, p. 540.

[2] *Deut. Zeitschr. f. Chirur.*, vol. vii., p. 18.

[3] *See* Schmidt's *Jahrbücher*, vol. 172, 4, and Hirsch's *Jahresbericht*, 1877, for an interesting summary of the antiseptic treatment.

should have come first, is that they who use the method should at least provisionally accept the theory on which the dressing is based; they should, so to speak, act as if they saw germs on everything. This, however, is not so imperative as the one just spoken of.

"For," remarks Lister, "those who are unwilling to accept the theory in its entirety, and choose to assume that the septic material is not of the nature of living organisms, but a so-called chemical ferment destitute of vitality, yet endowed with the power of self-multiplication. . . . such a notion, unwarranted though I believe it to be by any scientific evidence, will, in a practical point of view, be equivalent to the germ-theory, since it will inculcate precisely the same methods of antiseptic management. It is important that this should be clearly understood."

For the proper application of the antiseptic dressings to any wound made by a surgeon, the following things are necessary:

1. *Three Solutions of Carbolic Acid*, duly labeled: (*a*) 1 to 40 for the "protective," and for the "loose layer of gauze." (*b*) 1 to 30 for the spray. It is intended that the spray itself should be of the strength of 1 to 40; by using, however, this second solution of 1 part to 30, it will be found that the dilution accomplished by the steam will bring it down to the desired strength. However, this is a matter that should be tested by each surgeon for himself.[1] (*c*) A 1 to 20 solution, in which the sponges,[2] instruments (the latter for half an hour to "Listerize," as Volkmann says, the joints and the teeth of forceps, etc.), and the drainage-tubes are immersed. This solution is also used to wash the epidermis[3] adjacent to the proposed wound, the hands, and particularly the finger-ends, of

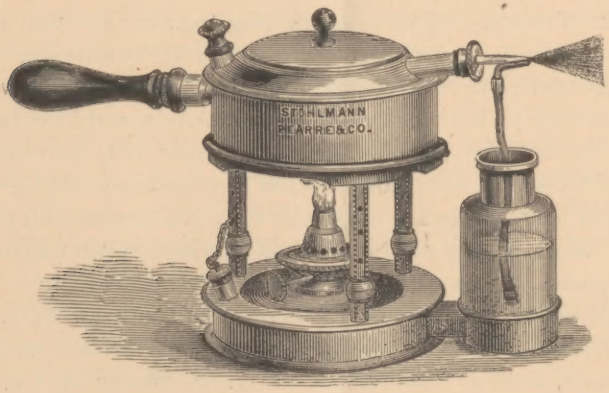
[1] For instance, in converting 19 ounces of water into steam, 57 ounces of carbolic solution, of 1 to 30, were used by my present atomizer, giving for the spray exactly the strength of 1 to 40.

[2] Sponges when not in use should, after being washed out thoroughly, be kept constantly in a 1 to 20 solution of carbolic acid.

[3] On the Continent the use of soap and water with a nail-brush, and a subsequent washing with ether, are advised prior to using the carbolic-acid solution. This appears to be an unnecessary addition to the already great complexity of detail.

the surgeon.[1] With the same solution injections are made into compound fractures, or wounds that have been exposed some time to the air; although, for the former, Mr. Lister has lately used a solution of 1 part acid to 5 of spirits of wine, employed in a manner to be alluded to shortly.

2. *A Steam-spray Apparatus.* The best is that devised by Lister himself. It is, however, quite costly, ranging in price from fifty to seventy-five dollars, and it was to meet this objection that the one before you has been constructed. With



its diminished cost some of the improvements of Mr. Lister's lamp have been sacrificed. It is, however, essentially the same. Its hollow wick, readily raised or lowered, affords a great and controllable heat. The spray-tube is in this apparatus fixed, an objection which in the majority of cases is of no moment. It will supply spray for over two hours. It therefore requires only that the boiler—containing twenty-two ounces—should be, as well as the lamp, full at the beginning

[1] To avoid some of the irritating and roughening effects of the acid, it is of service to anoint the hands with carbolic oil, 1 to 10, before exposing them to the spray. *See Boston Medical and Surgical Journal*, September 14, 1876; *British Medical Journal*, August 14, 1871, and *Lancet*, March 12, 1875. In the first journal, speaking of sponges, instruments, hands, etc., he (Lister) says not to introduce anything into a wound not cleansed by a 1 to 20 carbolic-acid solution. This is also stated in *Transactions of the International Medical Congress*, Philadelphia, 1876.

of the operation; and, with this precaution, it has been found practicable to dispense with the expensive and tell-tale windows of glass belonging to the original imported instrument.[1] The accompanying wood-cut gives a good representation of this lamp.

3. *Antiseptic Gauze.* This is made of a coarse-meshed cotton cloth (26 to 30 threads to the linear inch) called "mull" in Great Britain, but known here as cheese or dairy cloth. This cloth is heated beyond 212°, then sprinkled with its own weight of a mixture of carbolic acid 1 part, common resin 5 parts, and paraffin 7 parts, prepared by melting together the two latter in a water-bath, and then adding the acid, by stirring. The impregnated cloth is afterward kept under pressure in a water-bath box for an hour or two to disseminate equally the liquid, when the material is fit for use.[2] The resin, it is well known, gives off the acid very slowly—that is what is wished for—but it would leave the gauze too sticky were not the paraffin joined to it. Made in this way, it costs, in the Edinburgh Infirmary, unprepared, 1½d. a yard, and prepared, 2d. a yard.

The material from which I have had it made at the Roosevelt Hospital costs 3½ cents per yard, 28 inches wide, at wholesale, and is obtained from H. B. Claflin & Co., and costs, when prepared, 6 cents per yard. It is in its preparation, however, managed a little differently; for the heated cloth is immersed in the melted materials by being carried under rods near the bottom of the hot box containing the mixture, and, before emerging from this box, it is passed between two confronting rubber strips (in fact, weather-strips), which removes the surplus of the mixture; it is then caught on a roller, on which are payed at the same time, from another roller immediately below it, 3 to 5 layers of heated unprepared cloth. This tight roll of immersed and dry cloth has sufficient heat in it to cause the proper dissemination of the mixture through all the layers before it cools. Only occasionally is it found necessary to place the roll for further heating in a hot-air chamber. The impregnating layer is sometimes found a little

[1] The modified apparatus is furnished in a portable case by Stohlmann Pfarre & Co., 67 Chatham Street, at the moderate price of fifteen dollars.

[2] *Lancet*, March 13, 1875.

too stiff, and is used in the manufacture of bandages. By this procedure three hundred and fifty yards of prepared gauze can be manufactured at once in a much less space of time than by the other precedure. Details of the preparation of this and other materials are dwelt upon because mistakes are continually occurring; as confirmatory of this, it is necessary only to remark that a firm concerned in manufacturing the gauze in this city has failed, until recently, to appreciate the necessity of previously heating the cloth to insure the thorough penetration of the mixture into its substance, with the result of the central fibres being found imperfectly charged from neglect of this precaution.

4. *The Mackintosh*—a thin cotton-cloth with a layer of red vulcanized rubber on one side, used as a "sweat proof," in hats, and deriving its name from the manufacturers in Manchester, England. Other rubber-cloth or gutta-percha tissue will answer, but whatever is used must be impermeable, and should be held up to the light for the detection of holes, etc., before each dressing.

5. *Black rubber tubing*, varying in size from that of a small quill to that of the little finger, with numerous openings on the side, each half the diameter of the tube. These are for drainage. One or more are inserted, according to the size and depth of the wound and the number of its pockets. It is better to use two small ones in any given spot than one large one, as they will not separate the edges so much. To the outer end of these—cut square or beveling, as it may be required, to make them lie flush with the skin—are attached silk threads to secure them; or they can be prevented slipping inward by thrusting, as Volkmann does,[1] a fine cambric needle across the distal end. A number of threads of catgut are sometimes used in lieu of the tube, or in addition to it, so that the former can be withdrawn at any desired time, and the catgut left *in situ*. A bundle of horse-hair is also used.

6. *The Protective*, technically so called. This is ordinary oiled silk, coated on each side by a thin layer of copal varnish, to render it impermeable to carbolic acid (which gutta-percha

[1] "Samm. klin. Vorträge," Nos. 117, 118.

tissue is not), and then brushed over with a mixture of dextrine 1 part, starch 2 parts, and 16 parts of a 1 to 20 carbolic-acid solution. This coating causes the disinfecting solution to adhere smoothly to the protective, when it is immersed in it prior to an operation. The function of this protective is not an antiseptic one; it is really to protect the wound itself from the irritating effects of the carbolic acid stored up in the antiseptic gauze.

7. *Carbolized Catgut Ligatures*, made by putting catgut (or silk-worm gut)[1] into a mixture of carbolic acid 1 part, which is dissolved in one-tenth its weight of water, and then added to 5 parts of olive-oil. Do not mix the acid and oil together, and then add water; it spoils the catgut. The ligatures should remain in this mixture at least two months, and the longer they are kept in the solution the better they are said to be.[2] This, though quoted from Lister, is not exactly accurate, for most of the imported ligatures, even when prepared in Edinburgh by Gardner, are generally unreliable. Though, when successfully made, catgut ligatures generally answer their purpose, yet, as they have at times acted as foreign bodies, and provoked irritation, Mr. Lister has endeavored to improve upon this mode of preparation; and, at the International Medical Congress held at Philadelphia last year, he announced that he had made more satisfactory ligatures by a mixture of carbolic acid, glycerine, chromic acid, spirits of wine, and water; the exact formula has not, however, yet been given to the public. In this connection it is proper to allude to the painstaking endeavors toward perfection that have continually prompted the eminent promulgator of the antiseptic dressing; his persistent labors are attested by the many changes, always for the better, that have marked the progress of his treatment of wounds. These improvements, I regret to say, have been misinterpreted by many, as indications of unreliability, but they have all been steadily directed to the accomplishment of the end in view.

[1] Hirsch's "Jahresbericht," 1870, p. 322.

[2] Some marbles or pebbles, covered by a piece of glass, are put in the bottom of the bottle, to prevent the gut from touching the water that collects there. The imported ligatures are generally weak.

8. *Carbolized Silk Sutures*, made by plunging ordinary surgeon's silk into melted wax 10 parts, and 1 part carbolic acid. After being withdrawn, the surplus wax is removed by drawing the silk through a folded cloth. If there is not much tension in the part, catgut is often used for sutures.

Having all these things prepared, and the directions relative to the instruments, sponges, hands, and the adjacent skin, having been properly complied with, and the surface of the body not too much exposed, the operation or incision is begun by directing the spray, made as fine as possible,[1] upon or a little above the intended wound. The management of this is one of the most important duties to be intrusted to an assistant. Currents of air may turn away the cloud of spray, the position of the limb may be changed, the surgeon may unexpectedly place himself or his hands in the way, and thus screen the wound, etc.: all these difficulties must be looked after by the attentive lampholder.[2] The incision having been made,[3] all bleeding points must be secured by the catgut ligatures, both ends of which are to be cut off short; generally an ordinary reef-knot will secure the ligature properly; if you are in doubt, you may add a third one.[4] The wound is then to be closed accurately with the carbolized silk or gut sutures,[5] and a drainage-tube or tubes placed in the

[1] By contracting or partially plugging the delivery-tube—i. e., the one immersed in the carbolized solution—the spray is rendered finer.

[2] It is well to have an extra spraying apparatus accessible. Richardson's will answer. If the spray should suddenly cease, the wound should be at once covered with several layers of gauze wet with 1 to 40 solution; this is sometimes called the "guard."

[3] If during the operation any instrument has been temporarily laid aside, it should be dipped into the 1 to 20 solution, or held a moment or two in the spray near the lamp before again being introduced into the wound.

[4] This is particularly advisable when ligating a vessel in its continuity.

[5] Should any traction be required to approximate the lips of the wound, a deep relaxation-suture is to be resorted to, and held *in situ* by perforated disks of lead—a procedure similar to that used by Dr. Gurdon Buck, of this city, some ten years since, in plastic operations on the face. Adhesive straps, if used, should be short enough to be overlapped by the gauze dressing, and should previously be dipped in a hot carbolic solution of 1 to 20. Personal observation has convinced me that adhesive plaster will,

deepest parts of the wound, so as to drain off all accumulating fluids. A small piece of protective, previously dipped in the weak solution of 1 to 40,[1] but only sufficiently large to thoroughly cover it, is then to be placed over the line of junction of the edges of the wound, with openings cut in it for the drainage tube.[2] Over the wound now covered with the protective is to be placed a large and separate layer of gauze, which has been dipped in the weak solution of 1 to 40 of carbolic acid. This is used in order to nullify the putrefactive elements that may be deposited in the exposed layers of the dry gauze; which latter is, after stopping the spray, then applied in a thickness of eight folds, largely overlapping the wound, and having a piece of mackintosh with the rubber side down interposed between the 7th and 8th layers. If the discharge is likely to be great, a larger number of layers can be used, or extra layers placed where fluids would be most likely to gravitate. The mackintosh should be about one inch smaller than the gauze, since it is intended to convey any discharge that may soak through to it toward the edges of the dressing, where it can be detected by the surgeon or nurse while it is yet resting in antiseptic material. All fluids are thus compelled to permeate the whole dressing, and to be constantly in contact with the carbolic acid.

The dressing, now completed, requires only to be secured in place, which is best accomplished by bandages of the same gauze material, as they will not slip. The many-tailed bandage is to be preferred for stumps, since its application will not be so apt to displace the protective. If the edges of the dressing do not fit snugly to the skin, or if they come where the

in ordinary dressings, frequently interfere with primary union; so that, when its employment is demanded, I prefer to interpose a few threads of charpie between its surface and the line of the wound.

[1] In the strong solution of 1 to 20 it is often wrinkled or shriveled up.

[2] If, in an operation for the eradication of tumors, a large pocket is formed, or a stump is baggy, or persistent oozing occurs, a large sponge dipped in 1 to 20 solution is placed over a good-sized piece of protective, and over this the other dressings, secured by a firm bandage. The sponge is not generally required after the first dressing. It is also employed after opening large abscesses.

natural motions of the body render nicety of application difficult, the too free entrance of air can be prevented by either stuffing in pieces of crumpled carbolized gauze or salicylic cotton along the edges, or by using a bandage of elastic webbing, lightly applied so as not to give discomfort to the patient.

The dressing is changed, as a rule, whether the wound be accidental or from an operation, in twenty-four hours, even though it is not stained at its edges; and sooner, if the secretions are formed in a sufficient quantity to bring about this result. This often occurs by reason of the irritating nature of the carbolic acid, which increases to a considerable degree the secretions of the wound. If the protective is unchanged in color, the wound is certainly aseptic; if it is not, it will show dark-brownish spots, the result of the action of the liberated sulphur upon the lead in the oiled silk. These remarks about the protective hold good only of incised wounds. In contused wounds the changes of color are met with even though the wound is doing well.

To expose the wound, the same precautions as to hands, instruments, etc., are to be taken as at the operation. The spray is directed on the dressing, and particularly on its edges, and, the encircling bandage having been cut or removed, the folded gauze is carefully raised, while the spray is turned into the angle between it and the skin. The parts adjacent to the wound are lightly wiped by a carbolized sponge or cloth to remove the secretion, which is generally a bloody serum. If the evidence is favorable, washing out the wound is to be carefully abstained from, and the drainage-tube is not to be removed; nor is this to be done until the third or fourth day, unless some sign is recognized of its being choked up, as, for instance, by tension, etc. Whenever it is taken out it is cleaned in the stronger carbolic-acid solution of 1 to 20, and replaced previously shortened, if need be, according to the granulation or closure of the wound. Lister[1] keeps them in until the wound is nearly, if not quite, healed—that is, so long as the discharge is more than the mere drainage-opening will account

[1] *Lancet*, April 8, 1876.

for, cutting them off at each dressing, and finding them often at the last dressing loose on the gauze, with their track healed.

In a redressing everything is renewed, except the mackintosh, which can be washed off with the carbolic solution of 1 to 20, and used again. It is preferable, however, to have two pieces, so that the one removed from a soiled dressing can be cleaned prior to its being employed again, when it is, of course, to be dampened with the strong solution.

The renewal of dressings, after this one of examination, depends on the profusion of the discharge, the sensations of the patient, and the temperature elevation. The latter should, in a satisfactory case, be either normal throughout or but slight in amount, and subside within forty-eight hours or thereabout. If nothing wrong occurs, the dressing can be left on for weeks (Lister[1] says), if necessary, as it sometimes is in compound fractures, etc. In one case, by sprinkling the under-surface of the gauze with salicylic acid, he kept it on for six weeks, without either odor or irritation. Generally it is retained from two days to a week.

Such is the management of wounds which can be treated *ab initio* by the antiseptic method. For those coming under this treatment some time after their infliction, such as lacerated wounds, compound fractures, and the like, a somewhat different plan must be adopted. Take, for instance, a compound fracture. Under the spray the wound is to be explored, detached fragments taken away, *secundem artem*, and a stream of carbolized solution 1 to 20—or, better still (Mr. Lister states though I have only so far tried the former method), a stronger solution, of 1 part carbolic acid to 5 of spirits of wine (alcohol)—is to be injected into the recesses of the wound, by means of a soft rubber catheter attached to a syringe. Drainage-tubes, reaching to the ends of the fractured bone, are to be inserted, after which usual dressings are to be applied.

For suppurating wounds presenting themselves as such, to the surgeon, or wounds that have failed to remain aseptic—and experience shows that this can generally be traced to

[1] "Transactions of the International Medical Congress," p. 541.

some fault in the dressing—another procedure is resorted to. It must be remarked that this failure of a dressing is not shown merely by the presence of pus, but by the odor that emanates from it as well as by the spots in the protective, for aseptic dressings will always be without any smell. And here it is well to pause a moment to say that the antiseptic treatment will not always prevent the formation of purulent matter. This absence of pus is to be hoped for; but those who have fairly tried the method (Volkmann and others) freely admit the formation of pus. "It is only just to Mr. Lister," observes Mr. Thomas Smith, in the lecture already quoted,[1] "and essential in order to enable one to form a fair estimate of the results of his method, to remember that he is far from regarding putrefaction as the only cause of suppuration. On the contrary, he has long since pointed out that any antiseptic substance, such as carbolic acid, if applied continuously to the exposed tissues of a wound, stimulates them to granulation, and the granulations to the formation of pus, giving rise to what he calls 'antiseptic suppuration,' due to the direct chemical stimulus of the antiseptic."

My own experience has shown me that the appearance of pus followed, in several of my amputations, the daily flooding of the stump with the stronger solution, which promptly and markedly diminished when this was stopped, or the weak solution used.[2]

Hence the avoidance of washing out the wounds when they are found proceeding in a satisfactory aseptic manner, or simple abscesses when they are first opened.

But to return from this digression. When such suppurating wounds, old ulcers, or "failures," are met with, they are, previous to the use of the usual dressings, swabbed out with a solution of chloride of zinc, 40 grains to the ounce. This remedy, introduced by Campbell de Morgan to the profession, for the proposed destruction of the loose cells in the incision made for the removal of cancerous tumors, forms a film over the sur-

[1] *Lancet*, March 25, 1876.

[2] Lucas-Championnierre, "Chirurgie Antiseptique," reports the same fact, 1876.

face to which it is applied which will remain free from putrefaction for several days. Where, however, sinuses exist, leading to necrosed or carious bone, etc., it was formerly the custom of Lister, after the operation undertaken for the removal of the diseased bone, to inject these tracks, and necessarily the wound also, with the chloride-of-zinc solution, and then to apply the other antiseptic dressings. The anticipation that the zinc would entirely eradicate all putrefaction from the wound, while a thing to be aimed at, was hardly expected by him, and indeed was but seldom perfectly satisfactory; and it was only on a recent visit to Germany that he learned that Volkmann accomplished much better results by first forcibly and thoroughly scraping out the sinuses with a small, sharp spoon, on a long shank (devised by Von Bruns, of Tübingen), and subsequently injecting them with a carbolic solution of 1 to 20.[1]

In the preceding description I have endeavored to give, as clearly and accurately as possible, the details of this method, inasmuch as considerable difficulty and some confusion will be encountered by those who try to study them out in the articles that have appeared in the medical journals during the past three or four years. Some few points need only to be alluded to, such as boracic ointment, made of the strength of 1 part boracic acid, 1 part white wax, 2 parts paraffin, and 2 parts almond-oil, spread on lint, used in the place of the protective to correct the discharges coming from foul cases of caries, etc. Boracic lint, dry and wet—i. e., lint[2] dipped in a saturated boiling solution of the acid and dried, and the same dipped in a cold saturated solution and applied moist[3]—is employed in both clean and sloughing ulcers, as

[1] *British Medical Journal*, December 25, 1876.

[2] Or paper-lint, or loosely-felted paper, is much more absorbent than ordinary lint, and makes a very serviceable dressing.

[3] At 212° water takes up one-third its weight of the acid; at 60° it takes up one-twenty-sixth of the acid.

a precursor to the chloride-of-zinc solutions and the usual antiseptic dressings. In its application, the protective, dipped in the watery boracic solution, is placed over the ulcer, and outside of this is laid a larger piece of the dry boracic lint dampened with the watery solution. This dressing is resorted to likewise in skin-grafting, abrasions, putrefying burns, and operations about the penis, and, in fact, about those parts where it is often impossible to use the more cumbrous gauze-dressing. For sounds and other urethral treatments (as suggested by Rolleston, in 1868), 1 part of carbolic acid to 20 of oil is used, and found unirritating.

What results have been obtained by this mode of dressing wounds must necessarily be a question of absorbing interest to surgeons. A considerable amount of material, insufficient, undoubtedly, to answer satisfactorily such a question in all its branches, has now been accumulated, and at the same time ample enough to enable such deductions to be drawn, as to render it the duty of every one having the charge of surgical cases to diligently try it.

My own experience dates from March 1st of this year, and comprises a period of five months of hospital practice, three of which were spent in the Roosevelt Hospital, and two in the New York Hospital; both of these institutions, one six years old, and the other opened for the reception of patients only this year, being magnificently equipped for the care of patients.

The total number of cases which underwent the antiseptic treatment, with more and more thoroughness as time passed, was 56, 23 of which were under my own charge; and occurred both in hospital and private practice; 9 in the care of Drs. Markoe and Mason, who followed me in service at the Roosevelt Hospital; and 24 were kindly furnished me by Dr. W. T. Bull, Surgeon to the Chambers Street Hospital, to whom, let me state, I am additionally indebted for several valuable suggestions obtained by him in a recent visit to Edinburgh. This total comprises the following injuries and operations:

	CHAMBERS STREET HOSPITAL.		NEW YORK AND ROOSEVELT HOSPITALS.		
	Succeeded.	Failed.	Succeeded.	Failed.	Total.
Amputation of thigh		2[1]	3	1	6
" leg	1	1[2]	2		4
" ankle		1			1
" arm	1		2	1	4
" fore-arm	1				1
Compound fracture of thigh		2	2		4
" " leg	5	1	1		7
" " skull	3				3
Ovariotomy, and explorat'y incision			2		2
Strangulated hernia			2		2
Loose cartilage of knee-joint	1				1
Ligation of femoral artery			2		2
Excision of joints		1	2		3
Nerve-stretching			1		1
Abscess	1		3		4
Bubo			1	1	2
Abscess and caries of tibia			1		1
Removal of tumor				1	1
Crushed toes	1				1
Bursæ	1		1		2
Wounds	1		1	2	4[3]
	16	8	26	6	56

A glance at this table shows that of the sixteen cases at the Chambers Street Hospital there were eight failures, while in my own ward the failures were only six in twenty-six cases. There is a legitimate explanation for this disparity. In the Chambers Street Hospital, from motives of economy, the larger pieces of gauze were, as suggested by Lister, ordered to be washed and to be recarbolized. This was poorly done—so much so that, when an investigation was made to discover why the dressing had failed, the gauze was found to have been imperfectly cleansed and unfit for use.

In almost all the failures taking place under my own obser-

[1] Died from sloughing and secondary hæmorrhage on the fourteenth day.

[2] A double amputation; died from delirium tremens on the sixth day.

[3] Died from septicæmia and extensive sloughing of the wound.

vation, retrospection detected some imperfectly-followed detail, such as the too frequent washing out of the wound, bandages too loosely applied, defective spray, and (the most common cause) dressings left too long in a soiled condition. In none of my own failures, save in one case which died from septicæmia (hereafter given in detail), and one where the arm was amputated during profound septicæmia, was there anything more than ordinary free suppuration, which in itself determined the cessation of what was considered at first a troublesome dressing. Now I should wash such out with the strong carbolic or chloride-of-zinc solution, and reapply the gauze, etc.

The most interesting of these cases are herewith presented, in more or less brief outline. When not my own, the name of the attending surgeon is given.

Case I.—*A Supra-condyloid Amputation of the Thigh* (Stokes's) was my first operation under Lister's method, and its result exceeded any that I had ever witnessed in a large military and civil experience. It was as follows:

P. C., aged thirty-two, was admitted to the Roosevelt Hospital, November 9, 1876, for caries of the lower portion of the tibia, of many years' duration. The diseased bone was gouged out with apparent benefit, but subsequently, about January, 1877, the granulations had become sluggish and hard, and eventually took on an epitheliomatous appearance—a condition which was confirmed by microscopic examination. This gradually extended, with the usual concurrent symptoms, until the posterior border of the tibia became involved, and a false point of motion ensued. Upon the patient's consenting to the amputation proposed, the limb was removed, May 14th, under the carbolic spray produced by an ordinary spray-tube and bottle attached by a rubber tubing to the steam-pipes of the hospital heating-apparatus. This threw a heavy cloud of mist, and was in this respect evidently a great improvement on the usual spirit-lamp and boiler, but was attended by the disadvantage of the steam condensing in the rubber tubing (although the steam-pipe had its proper "blow-off"), which caused the emission occasionally of a little jet of warm water over the patient and operator. This watery discharge lasted, however, so short a time that it did not materially interfere with the spray-formation. Unfortunately, I may say that we have not yet overcome this difficulty, and in our other cases

were compelled to resort to the lamp previously described.[1] The limb was removed by a long anterior and a very short posterior flap. The femur was divided about half an inch above its articular surface, and the cartilage of the patella cut off by a flat forceps and its bony surface leveled, in order to be accurately applied to the face of the sawn femur. This done, the synovial ligaments stretching on each side of the patella were divided, to allow egress of secretion from the synovial pouch above, the wound closed after the cessation of the hæmorrhage by catgut ligatures, by catgut sutures throughout, except at the angles whence emerged the ends of the perforated drainage-tubes which traversed the stump. The usual protective and gauze bandage was then applied up to the trochanter.

At the next dressing, twenty-four hours later, everything was quiet. The skin adjacent to the wound was pale, and free from tenderness. The discharge was moderate in amount, of a bloody color, and free from any odor.

The stump was dressed again three days later when the tube was removed. Union by first intention had occurred, except where the tubes had been lodged. During this time, he had surprised me, even at my first visit to him the day after the amputation, by the ready and painless way in which he used the stump, and on the third day he actually *waved it about*, to show me how easy he was.

On the third dressing, May 20th, a pale spot half an inch across, on the farthest extremity of the anterior flap, showed, by its darkening a little, that it was dead, but its separation was accomplished with little or no irritation. In short, the patient was out of bed in eleven days, and, had my fears permitted it, he would have been out by the eighth day. Some of the sutures were removed at the fourth dressing, 22d inst., much reduced in size, and some were absorbed. The stump could then bear firm pressure with the hand. The absolute healing of the little ulcers resulting from the drainage-tubes took place a short time later. His temperature, the day after the operation, rose to 100½°, and after that did not at any time exceed 99½°.

Case II.—*A Second Supra-condyloid Amputation of the Thigh*, wherein failure threatened, but was averted.

T. M., aged fifty-four, was admitted to the Roosevelt Hos-

[1] Since writing the above, I have witnessed the satisfactory working of an ingenious contrivance of Messrs. Angelo and Rundquist, by which, through the interposition of a small copper ball in the steam-tubing near the spray tubes, the condensed moisture is collected and converted into steam by the divided flame of a fine gas-jet.

pital June 6, 1877, with an epithelioma of the left leg, of nine months' duration, which had attacked a cicatrix. The ulcer was then two and a half inches in diameter.

On June 21st, Stokes's supra-condyloid amputation (a modification of Gritti's) was performed under Lister's spray. Considerable oozing occurred, requiring sponges to be applied over the stump, secured by bandages, over which the gauze, etc., were applied. Drainage-tubes used. Dressing renewed next day. Temperature 100½°. Pulse 92. The stump did well, with but a little watery discharge. No pain was felt for four days, when a slight odor was detected, and the union of the flaps retrograded, with an elevation of the temperature to 103°. Burrowing was found next day to have occurred on the posterior aspect of the thigh, which was arrested by a counter opening, and drainage-tube there inserted, after washing the stump and track out with the carbolic acid 1 to 20. This arrested the inflammatory action, and the temperature fell to 99°, but the stump healed by granulation satisfactorily, though slowly. Granulations varied from a large and flabby condition to the small and irritable. This was relieved a little by applying boracic acid to the ulcer, with a continuance of Lister's treatment. Final closure hastened by the use of red-wash.

Case III.—*Amputation of the Arm*, performed on a youth of seventeen, for a railroad crush of the hand and forearm just above the elbow, by skin-flaps and circular division of the muscles, under the carbolic spray. Catgut ligatures used; drainage-tubes inserted into angles of wound; wound closed by carbolized gut sutures, and protective and gauze dressing applied to the stump. Union by first intention occurred, save at sites of drainage-tubes. No pus formed, only a slight, glairy, brownish discharge; no pain felt, and no swelling seen. First dressing twenty-four hours after operation, second on third day, and on the fifth day (third dressing) the tubes were withdrawn, by which time the union was firm, and at the next dressing the little ulcers produced by the tubes were closing rapidly. The temperature-table showed some elevation for a number of days, but this was due to the free suppuration and burrowing of a scalp-wound that had been dressed in the ordinary way. As far as the antiseptic treatment went it answered most admirably.

Case IV.—*Amputation of the Thigh*, by Dr. Mason, August 3, 1877, for a railroad-injury which had ground up the leg and caused considerable laceration of the lower third of the thigh. Circular amputation of the thigh just above its middle was performed the same evening, under antiseptic spray, with the ligatures, sutures, drainage-tubes, and dressings, as usual. The

femoral vein was also ligated. Temperature on the second day rose for a little while to 100½°, but after that to not more than a degree above the normal figure. On the third day this was the hospital record: "Patient passed a comfortable night; has no pain; temperature 99⅘°; stump looking beautiful, and not at all sensitive. There is primary union throughout the whole face of the stump, except at corners where the drainage-tube projects. The discharge is slight, reddish, and inodorous. The sutures (catgut) already seem partly absorbed." He went on steadily to recovery, without any untoward symptoms.

Case V.—*Amputation of the Leg*, by Dr. Markoe, October 9, 1877, for a railroad-injury involving the ankle-joint. The leg was removed by skin-flaps and circular division of the muscles, under the carbolic spray, and dressed after Lister's method. Six dressings were used in eleven days, and the wound healed by first intention, save at the drainage-openings. Only a glue-like discharge noted, never purulent. Temperature on second day, 100⅕°; same evening, 99½°, which it did not after this exceed. The result was eminently satisfactory.

Case VI.—*Compound Fractures of the Right Thigh and of the Right Leg, with a Lacerated Wound of Left Leg*, in a girl of fifteen, caused by a fall from the roof of a three-story house. The right femur was fractured in its middle third, the wound was transverse, two and a half inches long, and on the outer aspect of the limb. The tibia and fibula were broken in their upper third, and the ends of the fractured bones protruded from the wound in front. A laceration, four inches long, existed over the left ankle and leg. All dressed antiseptically. On the second day dressings changed; again on the fourteenth and twenty-seventh days, when only simple granulating ulcers were found, and all closing steadily. Wound of right leg was then dressed openly to admit of extension by weight and pulley, and subsequently the other wounds were similarly treated, as it had been found, in other cases, that the Lister treatment was open to the objection of tardy closure, and that the time had now arrived when it was better to leave it off, or resort to strapping, red-wash, etc. (This sluggishness of repair has been noticed by Lister, Dittel, Volkmann, and others, and is met by either abandoning the treatment, or by using salicylic acid or boracic acid on the wound, or, as I have found serviceable, by using the carbolized instead of the ordinary red-wash alluded to above—i. e., sulphate of zinc, grs. ij; comp. spts. lavender, ℥j; water, ℥ss; sol. carb. acid 1 to 20, ℥ss, the antiseptic dressings being continued.) The patient was up and about at the end

of the ninth week, when she accidentally refractured her thigh. Two weeks later firm union had taken place. During the course of this very encouraging case, the temperature, except on the sixth day, when it rose to 102°, did not exceed, at any other time, 101°, and was generally below that level. No swelling or pain was seen or complained of at any time, except in handling the limb. The discharge was purulent, odorless, and slight in amount.

Case VII.—*Another Compound Fracture of the Thigh, with Simple Fracture of the Ulna*, was admitted to the Roosevelt Hospital July 25, 1877. It occurred in a boy of fourteen, and was caused by a fall of about twenty feet. The ends of the femur protruded through the anterior part of the thigh, about its middle. The bone was found comminuted, and a fragment one inch long, and involving more than one-half the shaft, was removed. The wound was dressed antiseptically by the injection, by means of a soft rubber cathetre, of a 1 to 20 solution of carbolic acid, and the other steps of the method carried out, excepting that, through misconception on the part of the house-surgeon, a drainage-tube was not introduced. The next day—26th—his temperature was 104°, and he was delirious. On examination, I found that the wound was closed, and that a collection of several ounces of bloody inodorous serous discharge had occurred. The wound was therefore enlarged, as its edges had been strongly approximated by the swel ing that had ensued, a drainage-tube of good size introduced, the cavity well washed out with the strong solution, and the dressings reapplied. The same evening the temperature had fallen to 99⅘°, and although it rose the next day to 102⅕°, with a continuation of the delirium, yet after that time it sank to 99⅘°, above which it did not again pass during the further progress of the case. The subsequent discharges were slight, without odor, and non-purulent, until the seventh day, when pus appeared. The swelling also disappeared, and the limb had an uninjured appearance. By the twentieth day only a simple granulating ulcer remained with a short drainage-tube, which latter was done away with on the thirtieth day. As far as the wound went the patient did very well, but in this instance non union occurred, which has continued up to the date of the last record of the case, October 1st.

Whether this was a condition that might have happened under any treatment, or whether it resulted from the destruction of at least one inch of the bone, cannot, of course, be determined. Volkmann[1] reports that this result—non-union

[1] "Samm. klin. Vorträge," Nos. 117, 118.

—has obtained several times (three times in seventy-five cases) in the fractures treated antiseptically by him, and that it is probably due to the total arrest of the inflammatory œdema, which is always present even in a simple fracture, and which plays so important a part in the process of repair. What, in addition, materially contributes to the non-appearance of the œdema with him, is the quite firm pressure with which he purposely secures the antiseptic dressings. He therefore deems it advisable, as soon as possible, to immobilize the fractured limb, and preferably by coaptation-splints.

Cases VIII. and IX. were respectively operations for the relief of strangulated femoral (omental) and inguinal (intestinal) hernias. One, the femoral, required opening of the sac, and the exposure of quite a large extent of omentum to the influence of the spray, and the other was reduced without dividing the peritoneum. Both did extremely well, with entire union of the wounds on the seventh and fourth days.

Case X. *Ovariotomy*, for multilocular cyst weighing thirty-eight pounds. The carbolic solution used for spraying with in this, as in other cases, was made from absolute phenol,[1] which is less irritating[2] and more soluble than any other form, and is the only kind used by Lister. In this operation—first done antiseptically, it may be stated, by Nussbaum in 1875, and subsequently by Keith, Olshausen, and others—it will be remembered, it is customary to place a sponge or cloth over the intestine when passing the abdominal sutures, in order to absorb the blood effused by the needle. In this instance, a cloth wet with a 1 to 40 solution was resorted to for this purpose, and remained several minutes *in situ* without giving rise to any inflammatory reaction. The wound was closed with catgut sutures and without a drainage tube, and the other dressings applied, with numerous extra layers on each side of the clamp, so as to make firm pressure with the bandages. The strong salicylized cotton was stuffed in all places

[1] Obtained at Caswell, Hazard & Co.'s, New York.

[2] The less irritating salicylic spray, 1 to 300, might be used if deemed advisable. No special risk of carbolic-acid poisoning is met with in ovariotomy, as was supposed by Funk. This poisoning rarely occurs. Volkmann, however, had one fatal case from this cause, but Bardeleben believes that it arises from the use of impure acid. The acid has been detected several times in the urine by its black coloration in patients who were otherwise doing well.

needing protection, as over pubes, and adjacent to bony points, etc. The patient did very well, and was out of the house on the twenty-first day.

Case XI. *An Exploratory Incision through the Abdominal Walls for a doubtful Ovarian Tumor, by Dr. Mason.*—The case was ascertained to be one of hydatid tumors, and the incision, three inches long, was closed by catgut sutures—all done after the antiseptic method. Primary healing took place promptly in the principal portion of the wound, but some gaping occurred in its upper part from the early melting of the catgut sutures. In fact, wherever there is likely to be tension, or the support is to be given for any length of time, the carbolized silk or the wire "relaxation" suture should be employed.

Cases XII. and XIII. *Two Ligations of the Femoral Artery in Scarpa's Triangle for Popliteal Aneurism, by Dr. Markoe, at the Roosevelt Hospital, with Primary Union of the Incision.*—Dressing complete, except that the drainage-tube was not used.

Some recent observations reported at the Clinical Society in London,[1] by Mr. Bryant, show that the catgut ligature accomplishes the division of the internal and middle coats, like the silk ligature, and that, where the wound is treated openly, sloughing of the outer coat can also occur. In four cases where a *post-mortem* examination was made, this latter was met with once. In the cases that died on the twelfth, thirteenth, and nineteenth days, the ligature had melted away, and in the last instance a small knot was the only part left. In a case wherein I ligated, with a fatal result the carotid and subclavian arteries simultaneously for innominate aneurism, employing a triple knot to secure the ligature, I was unable to distinguish, on the fourteenth day, any trace of the catgut used, and the vessels were found satisfactorily occluded by the divided middle and internal coats. Only rarely does the ligature give way in a few hours, as has been remarked by Callender, Spence, Smith, and others. Probably this is by the slipping of the ordinary reef-knot; as, in one of Mr. Bryant's cases, in which death occurred fourteen hours after the ligation, the catgut was found intact, and the vessel occluded

[1] *Lancet*, October 20, 1877.

above and below. If, joined to this reliable obstruction of the artery, we can have, by the aid of the antiseptic dressing, primary or rapid union, secondary hæmorrhage and other risks can be almost done away with.

Case XIV. *Unsuccessful Nerve-stretching for Tetanus.*—The incisions, each two inches long, for exposing and stretching the sciatic and anterior crural nerves, were made under the antiseptic spray and by the usual dressings. These were changed on the sixth day, and the wounds were found healed, except at the points of exit of the drainage-tubes. These latter were removed, and a few days later, when exposed, the incisions were healed. The amelioration of the tetanic spasms and trismus lasted for nearly eight days, when they recurred, and the case terminated fatally on the fourteenth day after the operation.

Case XV. *Exsection of the Fourth Metatarso-phalangeal Joint*, for severe neuralgia of the foot and leg, was done on a girl of twenty-two, July 26, 1877, after the method suggested by Dr. Morton, of Philadelphia, viz., by an incision two and half inches long on the dorsum of the foot, and under the antiseptic plan. The wound healed by first intention, save, as usual, at the drainage-opening, which closed August 13th, no general or local reaction having at any time shown itself. She was discharged from the hospital, free from pain, August 21st.

Case XVI. *Unsuccessful Attempt to reunite Old Divided Tendons.*—I should not have undertaken this operation, except that my previous satisfactory experience with Lister's dressing had given me the confidence that I should not submit the patient to any risk of further impairment by the operation. The man had had the proximal phalanges of the middle and ring fingers of the left hand cut across the middle of the palmar aspect by a knife, some eight weeks prior to his admission to the hospital. The wound, he said, healed readily, but he found he had lost the power of flexing the fingers more than 10° to 15°. Under the spray I made a longitudinal incision in each finger, and found the proximal end of the deep tendon just within the palm, and the distal end above the first phalangeal joint, leaving a space of quite an inch in which there was total absence of tendon, nothing but a reddish friable band being found there. It was impossible to approximate the ends, and the operation was therefore abandoned. Under the gauze dressing, applied as usual, but enveloping the whole hand and a portion of the forearm, the wound healed by first intention, and the drainage-openings closed on the

tenth day. The man was discharged, with his condition as before the operation.

Case XVII.—This, with the next case, is an example of the conversion of an old suppurating wound into an aseptic one. It occurred in a man who had had his right wrist-joint opened by a hook tearing into it, several months prior to his entrance in the hospital. General arthritis of the carpal joints followed, with the formation of several sinuses. On September 17th, excision of the wrist-joint was performed according to the mode of operation known as Lister's—though, lately, he is reported as having abandoned the radical removal of the whole carpus, with the ends of the metacarpal bones, and those of the radius and ulna,[1] for the more simple gouging out of the diseased parts under the antiseptic spray and dressings. Not being able at that time to obtain the details of the new method, I followed the older one. The parts were removed according to rule, and the sinuses leading to the diseased bones, and necessarily the wound also, were injected with the chloride of zinc solution (40 grains to the ounce); and as the oozing of blood was difficult to control from the combined cause of spray, zinc, and Esmarch's bandage, the cavity of the wound was filled with carbolized sponges (1 to 20) secured by a wet gauze bandage, and the usual gauze dressings with the mackintosh put on over this, so as to cover the whole hand and forearm. The sponges were removed the next day, a large drainage-tube placed across the exsected portion and the dressings renewed, this time with the protective, etc. These were changed every third day. On the fourth day, the splint constructed by Lister for such cases was applied over the dressings; and although this only imperfectly permitted the carrying out of the injunction to frequently use passive motion, yet the performance of this, when the dressings were renewed, allowed a very good result to be obtained. No reaction occurred about the incisions, and but very little pus was formed. By October 8th (date of last report) the cavity of the wound had completely filled up, except a sinus due to the drainage-tube, and running across from one side to the other.

Case XVIII. *An Old Suppurating Palmar Ganglion, with Subfacial Inflammation involving Palm and Forearm*, was admitted to the New York Hospital, August 8th, 1877. An incision was made in two boggy points, one above the wrist and one in the palm, and drainage-tubes were put in after syringing out the tracks gently with the chloride of zinc solution. The antiseptic dressing was then applied. This was

[1] *Boston Medical and Surgical Journal*, October, 1876.

changed on the 11th, 16th, 20th, and 25th, when healing occurred. The patient did remarkably well, and very little suppuration ensued.

Case XIX. was a failure that terminated in death. A boy of twelve received an extensive laceration of the soft parts of the calf by being run over by a heavy cart, September 1, 1877. It was determined to try the effect of the antiseptic dressing upon the case, with a view of avoiding amputation. This was done, and the patient progressed very well for a week, when the dressing was discontinued, and thick layers of salicylized jute substituted, for the reason that the seropurulent discharges were so profuse as to require redressing twice a day, and in the last twenty-four hours became offensive from unavoidable neglect in changing the gauze, etc. During this whole time there was no œdema of the parts above, and but very little elevation of the temperature. With the putrefactive changes the thermometer rose, and swelling of the limb ensued. The patient rapidly developed septicæmia, and died September 14th.

As a full description of all the cases antiseptically treated, while of interest to those who may be engaged in carrying out this treatment for themselves, would occupy too much space for a paper of this description, I shall occupy but a short time in further referring to a few cases of interest that occurred in the charge of Dr. Bull. They are as follows:

Case XX. *A Compound Fracture of Right Tibia and Fibula in its Middle Third*, produced by a fall, was brought into the Chambers Street Hospital March 20th, 1877. It was put up in Lister's dressing after the wound had been washed out. At the end of the first week (i. e., sixth dressing) the wound had been converted into an ulcer without any formation of pus, only a serous sanguinolent discharge having been observed. Temperature at no time exceeded 101½°. Plaster-of-Paris splint was applied one month later, and on May 18th the patient was discharged cured.

Case XXI. *Compound Fracture of the Fibula, One Inch above the External Malleolus, with Fracture of the Internal Malleolus opening into the Ankle-joint.*—The foot was reduced, the wounds freely injected with a carbolic solution of 1 to 20, and the antiseptic dressings applied with an external boot-shaped splint. No local reaction occurred, nor was any pain felt. The temperature did not exceed 101½° at any time during the progress of the case, except on the fourth day,

when delirium tremens developed itself. Only a very little pus was formed at any time. The wounds were reduced to simple ulcers on the forty-ninth day, but the final cicatrization was slow. Discharged with good motion in the joint.

Case XXII. *Compound Fracture of the Tibia and Fibula, Middle Third*, with a wound admitting the little finger. Injected, and antiseptic dressings applied, but no drainage-tube. No reaction; only a slight serous discharge. Six dressings in eighteen days, when wound closed. Put up then in plaster splint, and discharged. Union firm on thirty-seventh day.

Case XXIII. *A Bursa over the Patella*, and of the size of half a lemon, was opened by a small incision, under carbolic spray; one ounce of fluid evacuated, and a small drainage-tube inserted after the cavity had been injected with a 1 to 20 solution of carbolic acid. A carbolized sponge was then applied as a compressor, and over this the antiseptic dressings. Primary union of serous surfaces occurred, and the patient was out of bed on the third day, and was discharged on the fourth day, with a sinus half an inch long, which healed in a week.

Case XXIV. *Removal of a Loose Cartilage from the Right Knee-joint by Direct Incision.*—This was accomplished under the carbolic spray, by a wound one and a half inch long, which was then closed by catgut sutures and the rest of the antiseptic dressing applied, except that no washing out or tube was used. The limb was put on a long posterior splint. Considerable pain was experienced for six hours, but from that time the progress of the case was completely satisfactory. No swelling or tenderness of the joint, or temperature elevation, followed. Forty-eight hours after the operation the dressing was changed, and the wound found closed by primary union. A little bloody serum was seen about the wound. The patient was discharged from the hospital on the seventh day, walking about.

While the foregoing list of cases does not embrace the whole number treated according to Lister's method, yet it shows quite a uniformity of success in a variety of operations and wounds. The feeling of certainty as to the result, which those older in the method refer to, has, speaking personally, decidedly augmented with the increase of experience. The total number—fifty-six—is, however, palpably insufficient for statistical inference; and, for the purpose of duly impressing you with the advantages of this method of treatment, I must bring before you the testimony of others who have been able

by it to overcome the most serious obstacles met with in surgical practice.

Saxtorph, of Copenhagen, who was the first on the Continent to follow Lister's teachings, says "that it has completely changed his principles of pathology and his surgical practice;" and in respect to another point of interest, he states that "he is equally sure that if he does not carry out the antiseptic treatment to its full extent, it is of no use whatever to apply carbolic acid to a wound, at least as regards the dangers that always accompany putrefaction."[1]

Nussbaum, in a report of the surgical cases treated in his clinic at Munich, in a very bad hospital where, prior to 1872, 80 per cent. of the wounds were attacked with hospital gangrene, says that "since then, to the year 1875 (the date of his last report),[2] there has not been a single case of this disease." To accomplish this, he tried the open treatment, the occlusion dressing, the water-bath, irrigation with chlorine or carbolic-acid solutions, salicylic acid in solution and in substance, and the putting on of Lister's antiseptic materials, such as the carbolic-acid paste, etc., but all were unable to combat hospital gangrene and pyæmia. "But when we applied," he continues, "to all our patients the newest antiseptic method, now in many respects improved by Lister, and did all operations according to his directions, we experienced one surprise after another; everything went well; not a single case of hospital gangrene occurred, . . . and pyæmia and erysipelas completely disappeared"—a statement that time has shown not absolutely true, though very near to it; for Lindpaintner,[3] his assistant, has lately published a list of 459 cases of severity, treated antiseptically, in which eighty deaths occurred, three of which were from pyæmia. In all these cases, only six cases of erysipelas were met with.

Thiersch, of Leipsic, the first surgeon in Germany to use the Lister method, declares that, "although the technical details may be modified, Lister's postulate"—exclusion of the atmospheric ferments from the wound—"will certainly never

[1] *British Medical Journal*, December 25, 1875.

[2] Idem, and "Die chirurg. Klinik zu München im Jahre 1875."

[3] *Deutsche Zeitschr. f. Chirurg.*, vol. vii., p. 187.

again be lost sight of." He it was who, in endeavoring to simplify the antiseptic treatment, brought into use salicylic acid. This disinfectant was employed by him in spray, while performing an operation, the wound of which was closed by antiseptic sutures, drained by rubber tubes, and covered by an inch layer of salicylized cotton of 10-per-cent. strength, over which a second layer, two inches thick, of 3-per-cent. salicylized cotton was placed, extending about a hand's breadth above the stump, for instance, and secured by a bandage without any mackintosh. Later on in his experience, he used jute, salicylized to a similar strength, in place of the cotton.[1]

(This substance, which is a veritable addition to the surgical armamentarium, is the inner bark of a Bengal plant [*corchorus capsularis*], and from it the gunny-bags of commerce are made. It is very absorbent, and makes an excellent dressing for freely suppurating wounds.[2]) This dressing was changed for the first time at about the tenth day, when the tube was removed. Healing of the wound was expected at the second or third dressing. He reports the trial of this and Lister's antiseptic treatment in one hundred and sixty cases, among which were fifty-one cases of major amputations, resections, and compound fractures, and of which only

[1] "German Clinical Lectures," Sydenham Society, p. 63, *et seq.*

[2] The 10-per-cent. salicylic cotton, the only kind required in the Lister dressing, is made by putting five pounds of hygroscopic cotton (a cotton deprived of its oiliness by being boiled in a 4-per-cent. solution of caustic soda, and recarded)[1] in a solution of eight ounces of salicylic acid and two and a half quarts of alcohol of 0.830 sp. gr., diluted with four gallons of water at 150° Fahr. The soaked cotton is piled up, not hung, to dry. It is customarily stained with carmine, to distinguish it from the 3-per-cent. cotton.[2] The jute is salicylized to a 4-per-cent. strength, which has, by reason of its permeability, been found sufficient. It is prepared by being immersed in a solution of two and a half ounces of salicylic acid, one pound of glycerine, and ten pounds of water, raised to a temperature of 158° to 176°.[3] This amount will suffice for five and a half pounds of jute. Jute is obtained at the Dolphin Manufacturing Co., 65 Duane St., N. Y., at eight cents per pound, and costs in hospital, when salicylized with Merck's acid, about forty cents a pound.

[1] Bruns, Chirurg. Prax., p. 145.

[2] Girard, Circular No. 3, Surg. Gen. Office, 1877.

[3] Thiersch, *op. cit.*

seven proved fatal. The results, the greater part of which were from the salicylic dressing, though very brilliant, have been so much surpassed by the Lister treatment, that, since the publication of Thiersch's statistics, it has been announced that he has given up salicylic acid and now uses Lister's method altogether.[1] Thiersch makes the statement that, however much the idea may be ridiculed, he entertains no doubt that failure often results from an under-estimation of the technical instructions; and those surgeons who regard the whole thing *a priori* as a kind of fashion, or even delusion, run a risk, on that very account, of attaining bad results.

Unfortunately, time will not permit me to quote the opinions of all the well-known surgeons who have tested and have approved the antiseptic treatment. I need only refer to Annandale, a colleague of Lister; Heath, of the University College Hospital, London; Pick and Holmes,[2] of St. George's Hospital; Croft, of St. Thomas's; Thomas Smith, of St. Bartholomew's, where Callender has had such good results by other methods of treatment to be described hereafter; to Esmarch, of Kiel, as well as to many other distinguished men, as indorsers of the efficiency of this method of treating wounds.

It has been thought that some points might be omitted from the at first troublesome *minutiæ*—some simplification of the method made; this, perhaps, will be accomplished as time advances and experience widens. Trials have already been made in this direction by Thiersch. Bardeleben,[3] too, has been carrying on a modification of the antiseptic treatment in his clinic, but he finds he cannot omit the most annoying feature of it—that is, the spray—though he weakens it to a 1½ per cent. solution. He uses, however, as a variation, the silkworm gut carbolized, and employs what he calls jute-cake, or jute rolled into flat masses, which are soaked in a 1 to 20 carbolic-acid solution, and secured by a bandage without any mackintosh. But his results are not so good as those afforded by the Lister method, though in the treatment of several hundred cases he reports that pyæmia and

[1] "Transactions of the International Medical Congress," p. 537.

[2] "Treatise on Surgery," p. 50.

[3] *Deutsche med. Wochenschr.*, Nos. 22, 23, 1876.

septicæmia did not occur, and erysipelas only once. Attempts to do away with the spray, by simply washing out the wound with the carbolic-acid or chloride of zinc solutions, have not proved satisfactory with him.

The most encouraging statistics presented by a modified antiseptic treatment are those furnished by Mr. Callender, of St. Bartholomew's Hospital,[1] and by Mr. Spence, an associate of Lister himself. Mr. Callender has given a report of forty-four amputations performed by him in the course of three years with only *one death*, or 2.27 per cent (viz., twenty thigh amputations, one death; sixteen of the leg, no deaths; two of the arm, no deaths; and six of the forearm, no deaths).[2]

Callender's method of treatment[3] is, briefly, to tie bleeding vessels with carbolized catgut, he having formerly used torsion to arrest hæmorrhage. He then washes out the stump with a carbolic solution of 1 to 20, or chloride of zinc 1 to 12, and, after inserting for drainage two pieces of carbolized gutta-percha tissue, loosely tied together with carbolized catgut, which straddle the bone and allow the gutta percha to emerge from the angles of the wound, he closes it with silver sutures taken some distance from the edge of the wound. Over this are now placed three layers of lint dipped in carbolized oil 1 to 16, covered by gutta-percha tissue and a thick covering of cotton wool, all fastened by a bandage. Rest is secured by a stump-splint, hinged to allow ready redressing. The bandages, etc., are changed from one to three or five days. The catgut, dissolving in two or three days, permits the withdrawal of the drainage-tents.

Spence[4] has had not so happy a result, having had twenty-six amputations and six deaths—23 per cent. His most recent method is, after washing the wound out with carbolic water and inserting a drainage-tube, to close it with sutures or straps, and to apply lint soaked in a saturated

[1] "St. Bartholomew's Hospital Reports," vols. ix. and x.

[2] These cases, it must be stated, are confessedly carefully-selected ones, many amputations being rejected for injuries that would probably be operated on by other surgeons.

[3] *British Medical Journal*, March 18, 1876.

[4] *Medical Times and Gazette*, October 28, 1877.

boracic-acid solution, or in carbolized oil 1 to 20. The whole is then covered with waxed paper.

Holmes has performed after Lister's method, save using the spray, thirty-two amputations, and had only three deaths—9.3 per cent.[1] All these cases make a total of one hundred and two amputations and ten deaths, or 9.80 per cent. of mortality by the modified antiseptic treatment. This mortality should be compared with the results attained in the same hospitals in years previous to the adoption of the present mode of treatment. In St. Bartholomew's, for instance, there had been, from 1853 to 1868, seven hundred and nineteen amputations and one hundred and fifty-four deaths—21.4 per cent. mortality; and in St. George's, in five hundred amputations of all kinds, there were one hundred and fifty-three deaths—30.6 per cent. mortality—of which seventy-five were cases of pyæmia.

This omission of the spray, with the observation of the other directions of Mr. Lister, has not, so far as my researches go, been systematically resorted to to any great extent except by Mr. Holmes, though one would think, from the results obtained in the treatment of compound fractures, and wounds exposed for a moderate length of time to the air, that it might be successful. Nevertheless, a number of trials have been made with antiseptic dressings differently applied, such as those of Pozzi in Paris,[2] where no spray was used, and, instead of the antiseptic gauze, carbolized cotton was employed, and over this was placed carbolized hygroscopic cotton; and instead of protective, gold-beater's leaf was substituted; and for the mackintosh, ordinary oiled silk. Seven cases of operation are given as the result of this treatment, only one of which was of magnitude, viz., an amputation of the leg in which union by first intention occurred. The imperfection of such reports constitutes at present the difficulty of comparing their results with those attained by Lister's method.

If we now take compound fractures of thigh, leg, arm, and forearm, which, together with amputation-wounds, are by com-

[1] "St. George's Hospital Reports," vol. viii.

[2] *London Medical Record*, March, 1877.

mon consent resorted to to test the value of any new method of treating wounds, and for obvious reasons, we find that Callender had forty cases of such injuries, with but one death—viz, 2.5 per cent. only of mortality. Spence reports so few cases of this sort—only three compound fractures, with one death—that they are useless for our present purpose.

There are two other modes of treating wounds that should be considered a moment, before endeavoring to appreciate by comparison the statistical value of Lister's dressing. I refer to the open treatment, and the cotton-wool dressing of Guérin. The open treatment is indicated by its name. The stump of an amputation is not closed; it is simply left exposed to the air, covered lightly by a cloth to protect it from flies, etc., and under it is placed a saucer to catch the secretions. It was introduced to notice in the early part of this century by Kern, a Vienna surgeon, whose name is sometimes attached to the method. It was, however, revived in 1856 by Vezin, of Osnabrück, as well as by Burow, Bartscher, and Humphrey. Latterly, the success that can be attained by this method has been made known to us by Dr. James R. Wood, of this city, who has published, through his house-surgeon,[1] fourteen cases of amputation treated in this way without a single death. An excellent *résumé* of the results of this treatment is given in an able article by Krönlein in the *Archiv für klinische Chirurgie* for 1875. He there compares the results obtained by it with those furnished by the antiseptic method. In presenting them to you for comparison, only the amputations or compound fractures heretofore referred to—to wit, of the thigh, leg, arm, and forearm—will be considered. From a number of amputations by the open method, furnished by Krönlein—viz., fifty-three, with fourteen deaths—the mortality from this method is shown to be 26.4 per cent.; and, of sixty-five cases of compound fractures likewise treated, the mortality was fourteen, or 21.5 per cent.; though, if he included, as he should have done, those fractures wherein amputation or resection was necessitated by the progress of the case, the mortality would have been 25.4—i. e., one hundred and two cases, with twenty-six deaths. Erysipelas was more common, also, in the open

[1] Dennis, *New York Journal of Medicine*, June, 1876.

treatment than by the antiseptic method. The duration of the treatment, again, was in favor of Lister's method, as two is to one—e. g., for thigh-amputations by the open treatment, the duration in hospital averaged 118.2 days; by the antiseptic treatment, 61.2 days; for leg amputations, open treatment, 87.5 days; antiseptic, 47 days; arm, open, 57.7 days; antiseptic, 28.7 days.

In respect to the cotton dressing of Guérin, we learn from Hervey [1] that the mortality of the amputations treated by this method amounted to 46.1 per cent.

Now, naturally to meet such figures as have just been given, and especially those of Callender, one turns, for the facts required, to Lister himself. Unfortunately, he has published but few cases, and those mainly to illustrate his method. The condemnation, therefore, for not making his results known, passed upon him in the discussion upon the subject of antiseptic dressings in the Clinical Society of London, is, so far as the English language is concerned, correct. But in 1874, in Langenbeck's *Archiv für klinische Chirurgie*, Reyher published a careful comparison between the results of treatment of Lister and his predecessor in the same hospital, the great Syme. These are extremely interesting in themselves, as well as for the purpose of contrasting with the statistics of others. Reyher collected one hundred and twenty amputations performed by Syme, in which there were twenty-eight deaths—a mortality of 28.3 per cent.; or, in leaving out the hand and foot amputations, there were seventy-five major amputations, with twenty-six deaths—a mortality of 33.3 per cent.; and, of these, there were sixteen from pyæmia and four from septicæmia. The number of amputations performed by Lister was one hundred and twenty-three, in which there were twenty-one deaths, or a mortality of 17 per cent. Taking out the foot and hand amputations, as in the preceding case, there remain seventy-six major amputations, with twenty deaths, or a mortality of 26.3 per cent. as against 33.3.[2] Only one of

[1] Thèse de Paris, Sur le pansement ouaté.

[2] Expressed differently: Syme, for pathological amputations, had 26.8 per cent. mortality; for injuries, 41.1 per cent. Lister, for pathological amputations, had 15.9 per cent.; for injuries, 40.6 per cent. mortality.

Lister's deaths occurred from a wound complication. Inasmuch as it has been asserted that the deaths charged by Lister to anæmia really resulted from diseases due to wound-poisoning, I have taken the trouble to examine his table of deaths, and find that, of the fourteen cases assigned to this cause, one had a secondary hæmorrhage, and died two days after it; one died between forty-eight and seventy-two hours after the operation, from other injuries, and twelve died within twenty-four hours—too early, therefore, for septic effects. Lister's wards, it must be remembered, are small—of a capacity of fifty-five beds, but often containing seventy-five patients—and are always over-crowded. The absence of pyæmia and septicæmia is therefore all the more striking in these figures of Reyher. Erysipelas has been with him, as well as with many of his followers, reduced to a rarity.

While the opinions and data just given show very clearly the advantages of the antiseptic treatment, and while the general impression of all surgeons witnessing that treatment in Lister's own wards has been favorable to the method, yet the statistics themselves do not equal those presented by Callender. It is difficult to make such a contrast as perfectly as could be wished, because of the want of sufficient details. It is desirable, for example, to know, in Callender's table, how many were pathological amputations, or what complications existed, if any, at the time of the operation, etc.; for, in an experience the most important yet offered to the profession on the subject of antiseptic dressings, these points are strictly elaborated by the reporter, Dr. Volkmann, of Halle.[1] This eminent surgeon has had, since the year 1874, excluding cases of ligature of arteries, operations on tumors, severe injuries of the hand, operations in which the abdomen was opened, etc., about ten thousand cases under the antiseptic treatment, rigidly carried out according to Lister's directions. Of this number, he states, more than a thousand were great operations and severe injuries. The amputations amounted to one hundred and eighty-three in one hundred and seventy-two pa-

[1] Congress of the Society of German Surgeons, *London Medical Record*, June 15, 1877.

tients, of whom twenty-three died—equal to 13.3 per cent.;[1] but twenty-three cases, with sixteen deaths, should be deducted to place them fairly in relationship to Callender's, and then the mortality would descend to the low rate of 2.87 per cent.!—only surpassed by Callender's 2.27! If the foot-amputations were cut off, as they should be—forty-two cases, with no deaths—the percentage would rise to 3.09. These results, whether Callender's or Volkmann's, are truly wonderful. Of the two methods—one strictly and the other the modified antiseptic method—judging from personal observation, that of Lister's is the most likely to afford the best results in inexperienced hands, and has an advantage in not requiring the dressings to be so often disturbed.

On this point Mr. Holmes, who, be it remembered, omitted with marked success the carbolic spray, says, in his "Treatise on Surgery" (1875), that, "allowing for this (that is, the effects of cleanliness, well-managed hospitals, etc.), I cannot but express my strong conviction of the value of the method of dressing wounds which Mr. Lister has introduced. I have frequently pointed out the perfect immunity from traumatic fever, which in some cases follows even the gravest injuries or operations thus treated; and, although I quite admit that a similar immunity follows after other methods of dressing, yet I think it is more common after that which is called the 'antiseptic system' than any other, and on that account I advocate the use of that system, as well as on account of its utility in hospital practice, as necessitating the dressing of important cases by the surgeons or house-surgeons themselves, and almost excluding the possibility of any subsequent inoculation."

Turning again to the results secured by the Lister treatment in compound fractures, with which we only have the open and the modified antiseptic treatment to compare it, even more encouraging figures are presented. Volkmann (not to allude to his other great successes) has had seventy-five compound fractures in seventy-three patients under his charge, and, with the aid of the antiseptic treatment, has not lost a single one,

[1] Compare with statistics of St. George's and St. Bartholomew's Hospitals, *ante*.

although amputation became necessary in eight of them. Add to this, as occurring at the same time in his hospital, fifty operations of osteotomy in thirty-eight patients, with only one death (from the hæmorrhagic diathesis), and you have a success that is unparalleled! The compound fractures included: thigh, one; knee, four; leg, forty-two; arm, six; elbow, five; forearm, fifteen.

The osteotomies were performed on the femur thirteen times, and on the tibia thirty-seven times. Resection for false joints was also done nine times successfully.[1] The comparison of these results of seventy-five cases and no deaths with the 25.4 per cent. of mortality by the open method or with the 38 per cent. of mortality by the ordinary treatment,[2] is too striking for comment. It will only bear association with Callender's forty cases and one death.[3] Many of these compound fractures of Volkmann's were machinery-accidents, and many had the lacerated muscles hanging out of the wound, and in several cases the skin was torn off from the knee to the ankle. As his experience grew, the resort to amputation became more and more seldom. This treatment also received a severe test in those cases of compound fractures where the large joints[4] were involved, which occurred in twenty-one cases, with the result of eleven times preserving the limb, with anchylosis taking place in only one case; which result, he says, surgery in former times can show nothing analogous to. He corroborates a statement made in the earlier part of this paper, that irrigation of a wound is to be avoided after the first dressing, as it disturbs the coagula, etc. By not doing this, and by removing the drainage-tube early, he has had primary union, without any remaining sinus, in hip, knee, shoulder, and elbow resections in four, eight, and sixteen days from the date of the operation. The early removal of the tube—in which point he differs from

[1] "Sammlung klinischer Vorträge," Nos. 117, 118. [2] Idem.

[3] In the Boston City Hospital, for the five years ending 1874, were one hundred and fifty-seven compound fractures, of which sixty-five died —41 per cent. From the Roosevelt and St. Luke's Hospitals I have notes of twenty-one cases and seven deaths—33.3 per cent.

[4] When this complication was encountered, the joint itself was opened, washed out with the carbolic solution, and drainage-tubes inserted.

the teachings of Lister—may be done from the second to the eighth day, or as soon as it is seen that no fluid flows out on moderate pressure.

As his results have been so good and his experience so large, it will perhaps be of service to shortly sketch his manner of treating compound fractures, especially as we have but little in English concerning the antiseptic treatment of these injuries. Since, with him, the first dressing decides the fate of the patient and the progress of the wound, much care must be spent on it. All counter-incisions, sawing off of the ends of the bones, extraction of loose splinters, adjustment of fragments, and disinfection, must be attended to at this dressing. As he believes it is necessary that the ends of the bones should be seen, he often widens the wound and scoops out the clot, so that the irrigation (with a 1 to 20 solution) can be thoroughly made against the fractured portions, and especially in or against the fissures caused by the injury. By this exposure of the bone, also, any portions of intervening muscles, etc., can be removed. Counter-openings are to be made if the wound is deep; and, if the fracture cannot be reached through the original wound, it is to be cut down upon by a free incision at the nearest point. After the irrigation, the drainage-tubes, small and numerous, are inserted to the fracture, not between it, and in all pockets, with their projecting ends trimmed off and held externally by a needle traversing them, and the wound finally closed up to the tubes by sutures. A second irrigation is now made, and the surplus fluid gently pressed out. No protective is employed, but from fifty to one hundred (*sic*) small layers of the gauze are placed over the wound, and then the usual piece of eight layers, with the interposed mackintosh, is firmly bandaged on with a wetted gauze bandage. All crevices and ill-fitting edges are stuffed with salicylized cotton, for he considers it an hermetically-closed dressing. This is removed the next day, and, as previously stated, as soon as the discharge ceases, the tube is withdrawn. If, at the second dressing, the bone is yet exposed, he scrapes the sides of the wound to make it bleed, so as to hide the bone by a coagulum to be organized under the dressing. When the wound becomes glassy-red the protective is to be used. The dressing is to be continued

until the granulations have filled the wound. If necrosis occurs, the wound will close over it until it is loosened, when it will be discharged, or be dissolved *in transitu*. Immobility of the fracture should be obtained early by outside splints and by a plaster-of-Paris bandage. When the latter is applied, he places over the wound a piece of cotton soaked in the carbolic solution 1 to 20; then he covers the rest of the limb with antiseptic dry cotton, and applies the plaster bandages. The fenestra is cut out under the spray, and antiseptic cotton is tucked under the edges and the gap filled up with the gauze. If the fenestra is large, the splint is put on in the usual way, and salicylic cotton is forced under the edges of the opening, etc., before the gauze is applied.

In his last sixty cases, by the constant improvement that has gone on in his dressings, the results he states have become almost ideal, and his severest cases have united like simple fractures.

Volkmann says of himself, that he only gradually got into the way of using the dressing properly—a statement likely to impart comfort, I hope, to a surgeon more than half discouraged by failures often inexplicable to him.

But one word more need be said, and that is in reference to the cost of this dressing. I have computed that the six dressings probably required for a successful thigh-amputation, allowing six yards of gauze to each dressing, two pieces of mackintosh, with the other materials, will average about sixty cents per dressing.

In concluding this long, and, I fear, from its necessary minuteness, fatiguing description of the antiseptic treatment of wounds, with the results that have been obtained, I trust that the experience presented will have been sufficient to convince the most doubting of its practical efficacy, and to induce them to put it into immediate use. Moreover, the vast saving of life, which a reduction in mortality such as is shown in this little table means, should, if continued, as it probably will be, entitle any one who has been the instrument in the accomplishment of such results to a high place in the list of man's benefactors; and it seems to me that among them the name of Joseph Lister must outrank in

medicine all of his century, not excepting the discoverer of anæsthesia.

MORTALITY TABLE.

		From Ordinary Treatment.	From Open Treatment.	From Modified Antiseptic Treatment.	From Strict Antiseptic Treatment.
Amputations	Thigh per ct.	21.4[1]	26.4[3]	2.27[4]	3.09[6]
	Leg per ct.	28.00[2]		9.80[5]	10.91[7]
	Arm per ct.				
	Forearm per ct.				
Compound Fractures	Thigh per ct.	38.00[8]	25.4[9]	2.50[10]	0.00[11]
	Leg per ct.				
	Arm per ct.				
	Forearm per ct.				

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[1] "St. Bartholomew's Hospital Report," *loc. cit.* [2] Spence's "Surgery." [3] Krönlein. [4] Callender. [5] Callender, Spence, and Holmes. [6] Volkmann. [7] Volkmann and Lister. [8] Lucae, quoted by Volkmann. [9] Krönlein. [10] Callender. [11] Volkmann.

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